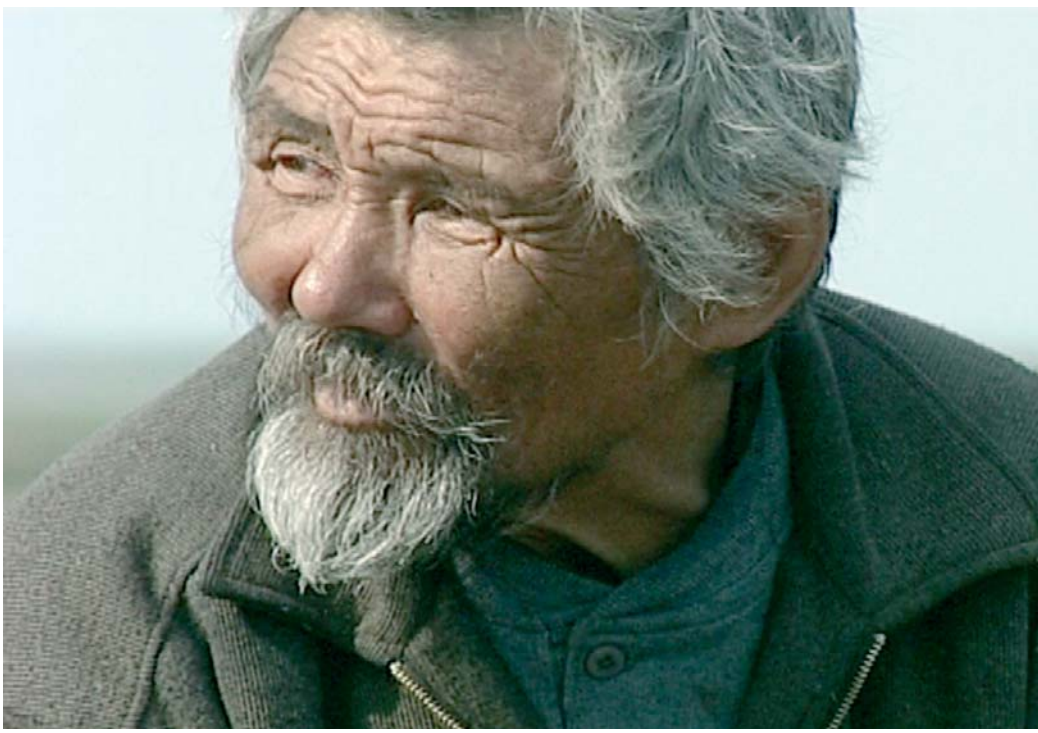
Chapter 9

Health effects associated with lifestyle, diet and exposure to PTS



9.1. Health risk factors

9.1.1. Tobacco smoking and alcohol intake

Tobacco smoking is found to be one of most common adverse habits practiced among the indigenous population, and is most prevalent in the Chukchi AO. The dietary and lifestyle survey found that almost 96% of the total adult indigenous population regularly consumes alcoholic drinks, at least once a month. As expected, vodka appears to be the preferred alcoholic drink throughout the Russian Arctic (Table 9.1.). About two thirds of the adult indigenous respondents (74% of men and 42% of women), reported consuming only vodka or vodka-like strong drinks.

Unfortunately, the original questionnaire used in the dietary survey did not provide the option of specifying consumption of homemade alcoholic drinks, which are illegal to produce. However, the average consumption of such beverages is estimated to range from 11 litres per year in communities in Taymir to 50 litres per year among indigenous communities in Chukotka. From the 2003 targeted survey, it was concluded that homemade alcoholic drinks are often consumed as a raw (rather than distilled) brew that may well be highly contaminated by POPs (see Chapter 6).

Alcohol intake in quantities amounting to 3 litres of ethanol per year by indigenous women, has been demonstrated to cause a number of adverse reproductive health effects; such as low birth weight, reduced gestational age of neonates, stillbirth and birth defects (Table 9.2).

In contrast, the smoking of tobacco does not seem to present a severe risk factor with respect to reproductive and developmental disorders in indigenous women and their infants. A statistically positive but moderate correlation has been found only for a reduction in the gestational age of newborns of smokers (Table 9.3).

In the meantime, the prevalence of some chronic diseases, and specifically, pulmonary diseases, appears to show a close correlation with reported intensity of tobacco smoking, illustrating the already well known dose-response relationship between the two traits (Table 9.4). A greater prevalence in reported liver disease is also associated with smoking intensity.

9.1.2. General well-being and other social factors

9.1.2.1. Low family income and level of education

It is commonly accepted that poverty and unemployment are two very important risk factors, which can compromise human health. The global trend is for a change in the nutritional patterns of less-favoured groups in the population, leading to lower animal protein, and higher fat consumption. In contrast, indigenous people of the North with low monetary incomes become more reliant on local food, and in particular fish and wild (marine) animals, which are generally more readily available to

Questions:	CAO		Kola		NAO		TAO	
	n	%	n	%	n	%	n	%
Do you smoke?	401	65.6	115	43.4	148	42.7	189	54.0
Do you drink beer?	97	15.9	55	20.8	137	39.5	181	51.7
Do you drink wine?	36	5.9	20	7.5	106	30.5	60	17.2
Do you drink vodka?	442	72.3	176	66.4	181	52.2	237	67.9

Table 9.1. Self-reported smoking habits and alcohol consumption: proportion of respondents giving a positive answer (Yes) to questions.

Annual alcohol consumption [1]	All reported fatal outcomes [2]	Spontaneous abortions	Stillbirths and structural malformations	Low birth weight, <2500 g	Premature births, <37 weeks
Not drinking	11.7	10.0	3.3	4.20	10.8
Under 3 L	14.3	12.7	4.8	6.30	9.5
3 L and more	18.5	11.1	5.6	11.10	14.8
Spearmen's correlation coefficient	0.99	0.25	0.94	0.99	0.82

Table 9.2. Prevalence of lifetime adverse outcomes of pregnancies (%), by reported alcohol consumption. [1] – calculated as ethanol equivalent; [2] – includes spontaneous abortions, stillbirths, ectopic pregnancies

Smoking intensity	Proportion of women reporting adverse pregnancy outcomes, %		
	Spontaneous abortions	Premature births, <37 weeks	Low birth weight, <2500 g
Non smokers (n=151)	13.1%	9.2%	7.2%
Moderate smokers (under 15000 cigarettes a year) (n=41)	9.8%	9.8%	4.9%
Heavy smokers (more than 15000 cigarettes a year) (n=43)	4.7%	20.9%	4.7%

Table 9.3. Prevalence of lifetime adverse outcomes of pregnancies (%), by reported smoking habits.

Smoking intensity	Proportion of respondents given positive answers (Yes) to the question:		
	Do you have any pulmonary disease?	Do you have any liver disease?	Do you have any chronic disease?
Non smokers (n=151)	3.9	9.2	37.9
Moderate smokers (under 15000 cigarettes a year) (n= 41)	7.3	7.3	26.8
Heavy smokers (more than 15000 cigarettes a year) (n=43)	11.6	25.6	44.2
Spearmen's correlation coefficient	0.98	0.82	0.55

Table 9.4. Prevalence of chronic diseases (%), by reported smoking intensity.

them than marketed foodstuffs. Since local fish and marine mammals in many Arctic areas are significantly more contaminated by POPs than imported foodstuffs, for those unable to purchase market products, the total burden of PTS is clearly elevated. Thus, poverty can be, and often is, a predisposing risk factor in the exposure of indigenous people in the Arctic to PTS (Table 9.5). Family income and the educational level of pregnant women, in general, both show negative correlations with PTS blood concentrations. This points to the probable impact of poverty and poor awareness regarding risks to health, on families in less favorable circumstances with respect to both income and educational attainment.

Contaminant	Monthly family income per capita	Duration of education
ΣPCB (ng/g)	-0.322	-0.208
Arochlor 1260 (ng/g)	-0.353	-0.203
ΣHCH (ng/g)	0.155	0.204
ΣChlordanes (ng/g)	-0.276	-0.067
ΣDDT (ng/g)	0.243	0.206
HCB (ng/g)	-0.458	-0.200
ΣToxaphene (ng/g)	-0.319	-0.091
Cd (µg/L)	-0.264	-0.184
Pb (µg/L)	-0.078	-0.660
Hg (µg/L)	-0.287	-0.245

Table 9.5. Spearman correlation coefficient for PTS blood concentrations and family monetary income, and total duration of education, in the group of pregnant indigenous women.

The most pronounced effect of low family income, is to promote the consumption of local sources of food fats which appear to be a major source of PTS exposure for indigenous populations residing in coastal communities (Table 9.6). The lowest level of fat intake was recorded for the indigenous population residing in the location of the Pechora River, where the main type of local food consumed are fresh water fish species which are generally low in fat.

9.1.2.2. Occupation

It was clear from the questionnaire study, that many indigenous people, and especially women, found difficulty in specifying their occupation; as the employment infrastructure in Arctic areas is often not well-developed. Although most women residing in indigenous communities reported some form of employment, job descriptions and job tasks described, as well as monthly incomes earned, indicate a fairly wide difference between formal occupations and the work actually undertaken.

In order to minimize possible misclassifications of occupations, all pregnant respondents were divided into three groups. The first group included women involved in animal farming and herding (outdoors); the second group included maintenance and service workers (indoors); and the third group, technicians, hospital and school personnel, fur/leather handling and workers involved with handcrafts (again indoors).

The groups with the highest exposure to POPs, (except for PCBs), were found to be the indoor occupational groups, who have potentially experienced a longer/higher exposure to household chemicals than outdoor workers (Table 9.7).

9.1.3. Self-assessment of environmental pollution

On the basis of data presented in Tables 9.8. and 9.9, air pollution is of little concern to indigenous people. The majority of people still believe that the Arctic is the least polluted, and most pristine area in the world, although this judgment may be based on inadequate public awareness of their local environmental situation. Women, as expected, are far more concerned about pollution than men.

PTS	Concentrations	Occupational groups (see section 9.1.2.2)				Total
			1st	2nd	3rd	
ΣPCB (n=208)	Over 1.0 µg/L	n	24	145	39	161
		%	70.8	78.5	76.9	
Arochlor 1260 (n=208)	Over 5.0 µg/L	n	6	49	13	68
		%	25.0	33.8	33.3	
ΣHCH (n=202)	Over 1.0 µg/L	n	7	63	20	90
		%	29.1	45.0	52.6	
ΣChlordanes (n=208)	Over 0.1 µg/L	n	14	93	30	137
		%	58.3	64.1	76.9	
ΣDDTs (n=202)	Over 2.0 µg/L	n	5	76	21	102
		%	20.8	54.2	55.2	
ΣToxaphene (n=205)	Over 0.5 µg/L	n	7	72	23	102
		%	29.1	50.7	58.9	

Table 9.7. Proportion of pregnant women (%) with higher PTS blood concentrations, classified by occupation group.

9.1.4. Indoor exposure to PTS

It is important to emphasize that the questionnaire study has, for the first time, provided overt epidemiological evidence of widespread, non-agricultural use of

	Coastal communities		Inland communities		Pechora River Basin community	
	Below 1500 roubles	1500 and over	Below 1500 roubles	1500 and over	Below 1500 roubles	1500 and over
Number of respondents	31	16	106	39	86	19
Country food fat, g	59.78	41.49	21.31	29.20	9.25	8.82
Store food fat, g	17.96	17.44	25.20	32.35	20.28	33.77
Ratio (country/store fat)	3.33	2.38	0.84	0.90	0.46	0.26

Table 9.6. Mean fat consumption (grams per day) and monetary income (monthly income calculated in Russian roubles) by indigenous women.

Answers	CAO		Kola		NAO		TAO		Total	
	n	%	n	%	n	%	n	%	n	%
Clean enough	212	62.4	120	73.2	120	51.5	108	54.5	560	59.9
Polluted	71	20.9	34	20.7	70	30.0	76	38.4	251	26.8
Don't know	57	16.8	10	6.1	43	18.5	14	7.1	124	13.3
Total	340	100.0	164	100.0	233	100.0	198	100.0	935	100.0

Table 9.8. Expressed concern over air pollution (women). Question: What is your feeling about the quality of ambient air in your settlement?

Answers	CAO		Kola		NAO		TAO		Total	
	n	%	n	%	n	%	n	%	n	%
Clean enough	196	72.3	82	82.0	71	62.3	99	63.5	448	69.9
Polluted	27	10.0	15	15.0	18	15.8	40	25.6	100	15.6
Don't know	48	17.7	3	3.0	25	21.9	17	10.9	93	14.5
Total	271	100.0	100	100.0	114	100.0	156	100.0	641	100.0

Table 9.9. Expressed concern over air pollution (men). Question: What is your feeling about the quality of ambient air in your settlement?

highly toxic substances in areas of the Arctic. Indoor and occupational sources of PTS exposure are likely to be a significant underlying contributor to the higher blood concentrations of persistent contaminants found in the arctic indigenous populations of Russia. Thus, for instance, almost half of the respondents in the Chukchi AO and Kola peninsula (Table 9.10) reported the regular use of a number of highly toxic substances against insects and rodents. The majority of those chemicals have not been properly labeled and their use is practically uncontrolled (see Chapter 4, Table 4.34). It was discovered, that at least some of these substances (most of which were imported from China) contain significant amount of POPs such as PCBs, DDT and HCH. The most contaminated substance, proved to be an insecticide named "Medifox super". This has been in widespread use since the early 1990's for general household use, as well as being applied to human skin and hair, especially of children, for the treatment of skin parasites such as itch-mites and lice. Considering the official reported prevalence of pediculosis and scabies, which affect from 11% to 35% of the total population resident in arctic indigenous communities, it is clear that the use of such insecticides could pose a significant risk of human exposure to POPs.

Questions Yes/No	CAO		Kola		NAO		TAO	
	n	%	n	%	n	%	n	%
Do you use any toxic chemicals against rodents?	279	45.7	113	42.6	90	25.9	54	15.4
Do you use any toxic chemicals against insects in your vegetable garden?	6	1.0	1	0.4	1	0.3	2	0.6
Do you use any toxic chemicals against insects in occupational settings?	18	2.9	1	0.4	16	4.6	1	0.3
Do you use any toxic chemicals against insects indoors?	270	44.2	111	41.9	55	15.9	50	14.3

Table 9.10. Use of insecticides/pesticides and other chemicals. Proportion of those giving a positive answer (Yes).

A large proportion of indigenous people surveyed (23 – 45%) reported routine use and sometimes domestic production, of materials containing lead (such as paint, ammunition, fishing equipment, etc.) (Table 9.11). This information suggests that more effort should be given to evaluating local sources of exposure, and caution applied in approaching the evaluation of risks associated with the global transport of PTS.

Questions	CAO		Kola		NAO		TAO	
	n	%	n	%	n	%	n	%
Have you used lead-containing paintings or other construction materials?	128	20.9	14	5.3	105	30.3	18	5.1
Do you use lead-containing materials for fishing?	199	32.6	32	12.1	76	21.9	29	8.3
If yes, do you make them yourself by means of lead melting?	119	19.5	20	7.5	34	10.0	14	4.0
Do you use lead-containing ammunition for hunting?	171	28.0	60	22.6	80	23.1	135	38.6

Table 9.11. Use of materials containing lead. Proportion of respondents given a positive answer (Yes) to questions.

Region	Women		Men	
	Yes	%	Yes	%
CAO	320	94.1	252	93.0
Kola peninsula	165	100.0	100	100.0
NAO	233	100.0	114	100.0
TAO	193	99.0	155	100.0
Total	911	98.3	621	95.8

Table 9.12. Consumption of local food (Question: Do you regularly consume local foods?).

Source of food	Kola Peninsula		Pechora River Basin		Taymir Peninsula		Chukotka Peninsula	
	Yes	No	Yes	No	Yes	No	Yes	No
Local food, including:								
Wild animal meat	100.0	0.0	97.1	2.9	100.0	0.0	100.0	0.0
Wild birds	37.7	62.3	89.4	10.6	93.8	6.2	87.4	12.6
Fish	99.6	0.4	97.6	2.4	99.2	0.8	99.8	0.2
Berries	98.5	1.5	98.2	1.8	76.8	23.2	98.2	1.8
Locally cultivated vegetables	98.3	1.7	46.1	53.9	0.0	100.0	24.5	75.5
Imported food, including:								
Farmed animal meat	82.0	18.0	89.8	10.2	96.9	3.1	89.4	10.6
Fish	45.9	54.1	11.1	88.9	6.8	93.2	28.3	71.7
Vegetables	93.2	6.8	87.5	12.5	99.2	0.8	94.5	5.5

Table 9.13. Proportion of respondents (%) reporting consumption of local foods.

9.1.5. Diet

Clearly, the Russian Arctic population is highly dependent on local foods (Table 9.12 and 9.13). Practically all the indigenous population in the project pilot areas reported dependence on traditional local

food in their diet. The high consumption of marine mammal meat and fat by the indigenous population of coastal Chukotka, is of particular note (Table 9.14).

Intake	seal meat	seal fat	walrus meat	walrus fat	whale meat	whale fat	Total average		
							Blubber	Meat	Total
Annual, kg	22	8.8	23	8.8	17	7.2	24.8	62	86.8
Daily, g	60	24.0	63	24.0	46	20.0	68.0	169	237.0

Table 9.14. Consumption of marine mammal meat and blubber by indigenous coastal population (in Uelen).

9.2. Health effects associated with exposure to PTS

9.2.1. Self-evaluation of health status

With the exception of the TAO population, most respondents believe that they are in good health. However, between 28 to 60% also reported that they had been told by a doctor that they might have a chronic disease (Table 9.15). However, the prevalence of health complaints made by native people is generally lower than that observed in non-indigenous arctic populations of the same age (62–79%) (Kovalev *et al.*, 2000). Given the extremely low life expectancy in Arctic indigenous populations (see Chapter 2), the low prevalence of reported health problems is likely to relate to lack of awareness regarding existing or developing health problems.

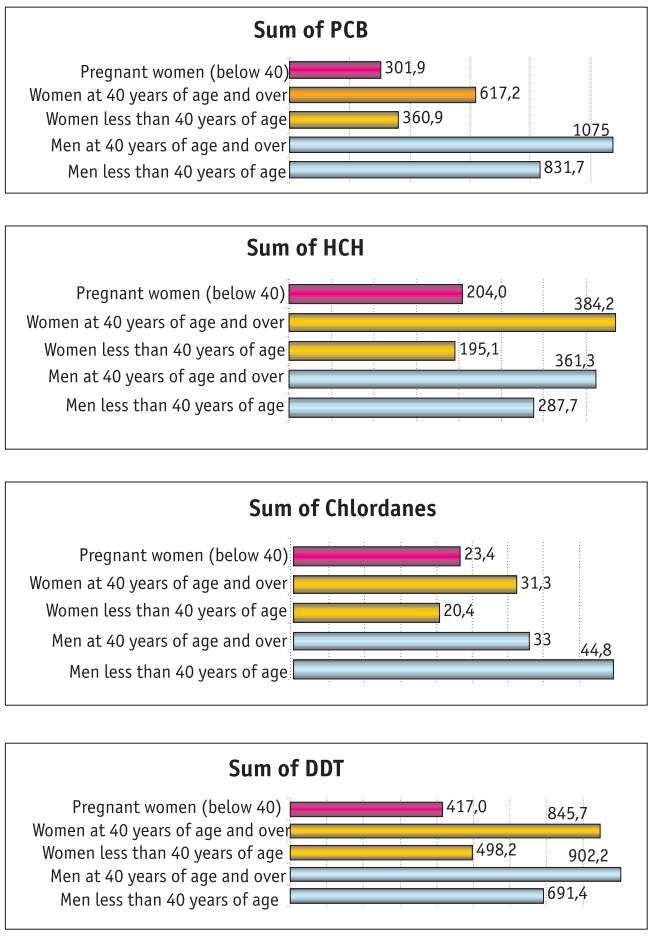


Figure 9.1. Concentrations (geometric means, ng/g lipid weight) of OCs in blood of indigenous people by age.

9.2.2. Blood concentrations of PTS: Variation

POP concentrations in serum are known to vary due a number of individual factors, e.g. age, diet, parity etc. This study has shown that the most pronounced differences are associated with gender and age. Thus, men older than 40 years of age showed a 1.3-fold increase in concentrations of total PCBs, DDT and HCH, compared to younger men living in the same communities (Figure 9.1). The differences between the two age groups in indigenous women are found to be greater than between men, with up to a 2-fold increase in POP concentrations occurring in older women. Pregnant women showed the lowest serum concentrations for a number of organochlorines, such as HCB, total toxaphenes, and, to a lesser extent, the sums of PCBs and DDT. A possible explanation for this phenomenon is that pregnant women, in accordance with medical recommendations, are often admitted to delivery departments 3–4 weeks prior to the expected date of birth, in

Question	CAO		Kola		NAO		TAO	
	Yes	%	Yes	%	Yes	%	Yes	%
Do you believe that you are healthy?	398	65.1	145	54.7	197	56.8	141	40.3
Has a doctor ever told you that you may have a chronic disease?	170	27.9	116	44.8	118	34.0	207	59.1

Table 9.15. Self-reported health problems.

Number of live births		ΣPCB	ΣHCH	ΣChlordane	ΣDDT	HCB	ΣToxaphene
1	n	78	75	78	75	78	78
	Mean	526.65	327.44	68.54	637.78	194.65	23.31
2	n	72	69	72	69	72	70
	Mean	404.67	202.16	48.69	475.40	180.77	19.27
3	n	30	30	30	30	30	29
	Mean	472.44	205.00	71.36	443.05	212.33	20.73
4 and more	n	28	28	28	28	28	28
	Mean	657.53	314.41	151.23	494.43	284.21	34.66

Table 9.16. Relationship between concentration (geometric means; ng/g lipid) of POPs in serum and parity.

Number of live births		Cd	Pb	Hg
1	n	75	75	75
	Mean	0.93	48.11	1.79
2	n	67	67	67
	Mean	0.97	44.18	2.26
3	n	29	29	29
	Mean	1.05	53.76	2.52
4 and more	n	28	28	28
	Mean	1.35	57.38	3.22

Table 9.17. Relationship between concentration (geometric means; µg/L) of metals in blood and parity.

Table 9.18. Spearmen correlation coefficients between concentrations of selected PTS in blood of pregnant indigenous women.

	Arochlor 1260 (ng/g)	ΣPCB (ng/g)	ΣHCH (ng/g)	ΣChlordanes (ng/g)	ΣDDT (ng/g)	ΣHCB (ng/g)	ΣToxaphene (ng/g)	Cd (µg/L)	Pb (µg/L)	Hg (µg/L)
Arochlo 1260 (ng/g)	-	0.870	0.285	0.606	0.173	0.665	0.589	0.205	0.143	0.236
ΣPCB (ng/g)	0.870	-	0.340	0.558	0.265	0.719	0.606	0.138	0.122	0.183
ΣHCH (ng/g)	0.285	0.340	-	0.427	0.674	0.231	0.356	0.015	0.026	-0.160
ΣChlor-danes (ng/g)	0.606	0.558	0.427	-	0.130	0.614	0.632	0.268	0.250	0.151
ΣDDT (ng/g)	0.173	0.265	0.674	0.130	-	0.051	0.146	-0.205	-0.064	-0.209
HCB (ng/g)	0.665	0.719	0.231	0.614	0.051	-	0.598	0.152	0.164	0.259
ΣToxa-phene (ng/g)	0.589	0.606	0.356	0.632	0.146	0.598	-	0.189	0.179	0.218
Cd (µg/L)	0.205	0.138	0.015	0.268	-0.205	0.152	0.189	-	0.303	0.238
Pb (µg/L)	0.143	0.122	0.026	0.250	-0.064	0.164	0.179	0.303	-	0.091
Hg (µg/L)	0.236	0.183	-0.160	0.151	-0.209	0.259	0.218	0.238	0.091	-

	ΣPCB (ng/g)	Arochlor 1260 (ng/g)	ΣHCH (ng/g)	ΣChlordanes (ng/g)	ΣDDT (ng/g)	HCB (ng/g)	ΣToxaphene (ng/g)	Cd (µg/L)	Pb (µg/L)	Hg (µg/L)
ΣPCB (ng/g)	-	0.937	0.613	0.260	0.565	0.421	0.569	0.173	0.104	0.369
Arochlor 1260 (ng/g)	0.937	-	0.590	0.288	0.565	0.377	0.604	0.224	0.111	0.367
ΣHCH (ng/g)	0.613	0.590	-	0.313	0.467	0.460	0.224	0.063	0.250	0.118
ΣChlordanes (ng/g)	0.260	0.288	0.313	-	0.043	0.059	0.055	0.036	0.211	0.155
ΣDDT (ng/g)	0.565	0.565	0.467	0.043	-	0.601	0.309	-0.147	-0.298	0.060
HCB (ng/g)	0.421	0.377	0.460	0.059	0.601	-	0.062	-0.442	-0.350	0.290
ΣToxaphene (ng/g)	0.569	0.604	0.224	0.055	0.309	0.062	-	0.394	0.035	0.335
Cd (µg/L)	0.173	0.224	0.063	0.036	-0.147	-0.442	0.394	-	0.508	0.277
Pb (µg/L)	0.104	0.111	0.250	0.211	-0.298	-0.350	0.035	0.508	-	0.163
Hg (µg/L)	0.369	0.367	0.118	0.155	0.060	0.290	0.335	0.277	0.163	-

Table 9.19. Spearmen correlation coefficients between concentrations of selected PTS in blood of women of the general indigenous population.

Table 9.20. Spearmen correlation coefficients between concentrations of selected PTS in blood in adult indigenous men.

	ΣPCB (ng/g)	Arochlor 1260 (ng/g)	ΣHCH (ng/g)	ΣChlordanes (ng/g)	ΣDDT (ng/g)	HCB (ng/g)	ΣToxaphene (ng/g)	Cd (µg/L)	Pb (µg/L)	Hg (µg/L)
ΣPCB (ng/g)	-	0.974	0.656	0.222	0.501	0.163	0.647	0.523	0.389	0.588
Arochlor 1260 (ng/g)	0.974	-	0.636	0.250	0.476	0.107	0.630	0.461	0.354	0.545
ΣHCH (ng/g)	0.656	0.636	-	0.080	0.348	0.224	0.370	0.390	0.372	0.327
ΣChlor-danes (ng/g)	0.222	0.250	0.080	-	0.204	0.022	0.115	0.285	-0.073	0.064
ΣDDT (ng/g)	0.501	0.476	0.348	0.204	-	0.582	0.232	-0.001	0.089	0.063
HCB (ng/g)	0.163	0.107	0.224	0.022	0.582	-	-0.288	-0.303	-0.159	-0.104
ΣToxa-phene (ng/g)	0.647	0.630	0.370	0.115	0.232	-0.288	-	0.478	0.467	0.360
Cd (µg/L)	0.523	0.461	0.390	0.285	-0.001	-0.303	0.478	-	0.605	0.524
Pb (µg/L)	0.389	0.354	0.372	-0.073	0.089	-0.159	0.467	0.605	-	0.413
Hg (µg/L)	0.588	0.545	0.327	0.064	0.063	-0.104	0.360	0.524	0.413	-

order to receive proper health care. This includes special nourishment, which is completely based on imported foodstuffs. A further issue to be taken into consideration, is that the group of pregnant women are representative of the whole study area, rather than of specific communities. Therefore, the possibility of some inter-community variation cannot be ruled out.

Parity (more precisely the number of breast fed children) also needs to be considered as a factor capable of reducing POP serum concentrations (Tables 9.16 and 9.17). As previously mentioned, between 68% to 94% of indigenous infants are breast fed for a period longer than 6 months and almost a half of them for over one year. Those women having more than one child, but less than 4 children, showed significantly lower concentrations of HCB, DDE and PCBs. The relative increase seen in POP levels of mothers having 4 or more children, is likely to reflect the age-dependency effect in POP levels, mentioned above, which is potentially greater in this group of women.

Most of the organic contaminants show positive correlations to each other, whilst for inorganic contaminants this is not the case (Tables 9.18–9.20). For pregnant women a closer relationship is found between total PCBs and HCB (neither of which are pesticides), and which presumably have one or more common exposure routes. Organochlorine pesticides are also positively correlated to each other.

The correlation pattern obtained from statistical analysis of PTS blood concentrations for the general indigenous population appears differ slightly from that observed in pregnant women. In fact, relationships between concentrations of individual POPs in blood are generally not very close. The majority of r-values range from 0.2 to 0.6. For inorganic contaminants, only the Pb-Cd pair shows a moderate association.

9.2.3. Health effects associated with PTS blood concentrations

9.2.3.1. Reproductive and developmental effects

9.2.3.1.1. Main associations between exposure and effects

A number of experimental findings suggest that exposure to PTS is associated with reproductive health effects. Epidemiological evidence of this, however, is very limited. A basic statistical analysis of recorded adverse outcomes of pregnancy in indigenous women, and their current PTS blood concentrations, has shown that there is a statistically significant, but relatively low association (RR-value from 2.05 to 2.77) between the prevalence of premature births and blood concentrations of lead exceeding 30 µg/L, cadmium exceeding 1.0 µg/L and PCBs (as Arochlor 1260) exceeding 5.0 µg/L (Table 9.21). In addition, the identical concentrations of PCBs and Cd measured in both maternal and cord blood are found to correlate with reduced birth weight of newborns (either below 2500 g or 3000 g), at a similar level of statistical significance (Table 9.22).

There have been four reported cases of serious structural malformation and six stillbirths in the study group of pregnant indigenous women. The geometric means of concentrations of total PCBs, DDTs and Hg in the maternal blood found in these adverse cases, proved to be 1.7–2.0 times higher than in women where there were no reported adverse outcomes (Table 9.23).

PTS			Gestational age: Under 37 weeks	Gestational age: 37-40 weeks	Total
Pb	below 30 µg/L	n	3	50	53
		%	5.70	94.3	100.0
	30 µg/L and over	n	23	123	146
		%	15.80	84.2	100.0
RR			2.77		
Chi-Square Tests (p-value)			0.05		
Spearman correlation coefficient			-0.132		
Cd	below 1 µg/L	n	10	105	115
		%	8.7	91.3	100.0
	1 µg/L and over	n	15	69	84
		%	17,9	82.1	100.0
RR			2.06		
Chi-Square Tests (p-value)			0.05		
Spearman correlation coefficient			-0.126		
ΣPCB	below 1.0 µg/L	n	13	127	140
		%	9.3	90.7	100.0
	1.0 µg/L and over	n	14	54	68
		%	20.6	79.4	100.0
RR			2.22		
Chi-Square Tests (p-value)			0.023		
Spearman correlation coefficient			-0.158		

Table 9.21. Prevalence of preterm pregnancy and concentrations of PTS in blood of indigenous women.

Contaminant			Birth weight, g: Below 2500	Birth weight, g: Below 3000	Total
Hg	below 2 µg/L	n	20	92	112
		%	17.9	82.1	100.0
	2 µg/L and over	n	17	41	58
		%	29.3	70.7	100.0
RR			1.64		
Chi-Square Tests (p-value)			0.08		
Spearman correlation coefficient			-0.132		
Cd	below 1 µg/L	n	32	128	160
		%	20.0	80.0	100.0
	1 µg/L and over	n	5	5	10
		%	50.0	50.0	100.0
RR			2.50		
Chi-Square Tests (p-value)			0.02		
Spearman correlation coefficient			-0.171		
ΣPCB	below 1.0 µg/L	n	25	110	135
		%	18.5	81.5	100.0
	1.0 µg/L and over	n	13	30	43
		%	30.2	69.8	100.0
RR			1.93		
Chi-Square Tests (p-value)			0.10		
Spearman correlation coefficient			-0.122		

Table 9.22. Prevalence of low birth weight newborns and concentrations of PTS in cord blood.

Table 9.23. Concentrations (geometric mean; µg/L) of PTS in blood of indigenous women reporting stillbirths and structural malformations.

Group	Number	ΣPCB	Aroclor 1260	ΣHCH	ΣChlor-danes	ΣDDT	HCB	ΣToxa-phene	Cd	Pb	Hg
No adverse outcome reported	204	2.29	5.38	1.26	0.51	2.53	0.97	0.19	1.02	48.91	2.26
Women reporting stillbirths and serious birth defects	8 (3.4%)	3.90	10.22	1.67	0.87	4.48	1.42	0.19	1.20	33.43	3.48

Table 9.24. Concentrations (geometric mean; µg/L) of PTS in blood of indigenous women reporting lifetime spontaneous abortions.

Study area and effects	n	ΣPCB	Aroclor 1260	ΣHCH	ΣChlor-danes	ΣDDT	HCB	ΣToxa-phene	Cd	Pb	Hg
Kola Peninsula											
No adverse outcome reported	15	1.24	2.94	0.58	0.02	3.21	0.42	0.04	0.42	29.83	1.23
Spontaneous abortion	2 (11.8%)	2.13	4.22	1.18	0.07	2.12	0.48	0.01	0.32	30.50	0.50
NAO											
No adverse outcome reported	36	1.96	4.81	0.63	0.09	2.70	0.76	0.07	0.84	41.38	1.19
Spontaneous abortion	3 (7.7%)	3.24	7.15	0.50	0.03	2.02	0.86	-	1.24	41.65	0.75
TAO											
No adverse outcome reported	66	1.93	3.80	1.08	0.08	2.43	0.69	0.12	0.94	59.99	2.82
Spontaneous abortion	11 (13.8%)	1.98	4.14	1.08	0.07	2.38	0.85	0.09	0.83	52.78	2.59
CAO (inland)											
No adverse outcome reported	58	1.80	3.93	1.12	0.53	2.21	0.84	0.06	0.95	41.03	2.14
Spontaneous abortion	3 (4.8%)	1.01	2.26	1.11	0.08	2.12	1.18	0.06	0.70	32.83	4.60
CAO (coastal)											
No adverse outcome reported	29	4.62	12.37	2.65	1.29	3.07	2.14	0.69	1.59	57.66	1.92
Spontaneous abortions	7 (18.4%)	2.93	7.77	1.46	0.74	2.22	1.14	0.22	1.12	48.33	2.37

PCB concentration range		Birth weight, g			
		below 2500	2500-2999	3000 and over	Total
below 1.0	n	5	10	67	82
	%	6.1	12.2	81.7	100.0
1.0 – 1.9	n	3	14	73	90
	%	3.3	15.6	81.1	100.0
2.0 – 4.0	n	4	14	34	52
	%	7.7	26.9	65.4	100.0
Over 4.0	n	4	8	19	31
	%	12.9	25.8	61.3	100.0

Table 9.25. Prevalence of low birth weight newborns (%) and concentrations (µg/L) of total PCB in maternal serum.

PCB Concentration range		Gestational age, weeks		
		Under 37	Over 37	Total
Less than 1.0	n	7	75	82
	%	8.5	91.5	100.0
1.0 – 1.9	n	5	85	90
	%	5.6	94.4	100.0
2.0 – 4.0	n	10	42	52
	%	19.2	80.8	100.0
Over 4.0	n	5	26	31
	%	16.1	83.9	100.0

Table 9.26. Prevalence of premature births (%) and concentrations (µg/L) of total PCB in maternal serum.

Some weak associations were also found between the prevalence of lifetime spontaneous abortions and the level of blood concentrations of PCBs and HCHs in pregnant indigenous women of the Kola Peninsula and the Nenets AO, whereas for the Chukchi AO group of pregnant women, the prevalence of spontaneous abortions is closely associated with blood concentrations of total Hg (Table 9.24). Unfortunately, the study protocol did not allow for the separation of organic and inorganic mercury compounds, which are known to have very different toxic profiles including that of reproductive toxicity.

9.2.3.1.2. Dose-response relationships

Dose-response relationships for reproductive health effects observed in the entire group of pregnant women can be demonstrated by a more detailed breakdown of PTS blood concentrations (Tables 9.25 and 9.26). It is clear that total PCB serum concentrations in maternal serum above the level of 2.0 µg/L, seem to be capable of affecting both the birth weight and gestational age of newborns; whereas the prevalence of fatal outcomes of pregnancy increase significantly at higher levels of PCB exposure, above 4.0 µg/L (Table 9.27).

Among inorganic contaminants, a clear dose-response relationship has been found between total mercury concentrations in maternal blood and the prevalence of low birth weight. Other adverse outcomes showed a U-shape curve, with a higher lifetime prevalence occurring in the group of women with Hg concentrations below 1 µg/L, and with the highest response from the group with concentrations over 1.4 µg/L (Table 9.28).

9.2.3.1.3. Gender dependent health effects

It has been found that the gender of indigenous offspring can be significantly affected by an increase in maternal blood concentrations of lead, Arochlor 1260 and total PCBs. Mothers are more likely to have daughters, if their exposure to POPs was relatively high. This did not appear to be the case, with increased blood concentrations of Pb, Cd or total mercury. (Table 9.29). In total, the study group of indigenous newborns showed a higher ratio of males/females (1.32) than the national average (1.06), with this ratio higher even than that found in the top 'male prevalent' nations such as Korea (1.14) and China (1.09) (www.globalstat.com), (Figure 9.2). Interestingly, these reproductive and developmental effects appear to show a closer association with blood concentrations of the lower chlorinated congeners of PCBs, such as 28; 31; 52; 99 and 118 (Figure 9.3). It was also found that female newborns are at a higher risk of low birth weight and premature births than male newborns. The frequency of these adverse out-

PCB concentration range		Adverse outcomes: All fatal outcomes	spontaneous abortions	Birth defects and stillbirths	Total number of women
Below 1.0	n	9	8	1	82
	%	11.0	9.8	1.2	100.0
1.0 – 1.9	n	16	13	2	90
	%	17.8	14.4	2.2	100.0
2.0 - 4.0	n	6	6	1	52
	%	11.5	11.5	1.9	100.0
Over 4.0	n	7	4	4	31
	%	22.6	12.9	12.9	100.0

Table 9.27. Prevalence of fatal outcomes of pregnancy (%) and concentrations (µg/L) of total PCB in maternal serum.

Biomarker of effect (n)		Maternal blood concentrations, µg/L: Less than 1.0	1.0 - 1.4	Over 1.4	Total (199)
Baby weight at birth, g	Less then 2500 (14)	14.3	21.4	64.3	100
	2500-2999 (39)	28.2	15.4	56.4	100
	3000 and over (146)	37	15.1	47.9	100
Adverse outcomes	Spontaneous abortions (24)	29.2	12.5	58.3	100
	Stillbirths and malformations (8)	50	12.5	37.5	100
	All fatal outcomes (30)	36.7	13.3	50	100

Table 9.28. Prevalence of lifetime adverse outcome of pregnancies (%) and concentrations (µg/L) of mercury in blood.

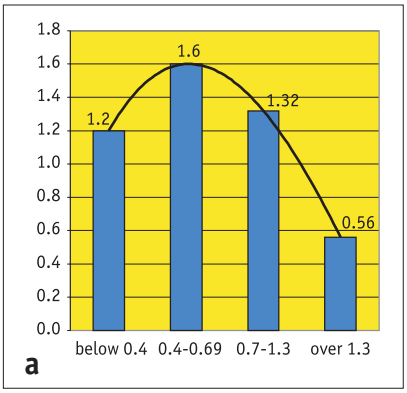


Figure 9.3. Relationship between pregnancy outcome (male/female sex ration of newborns) and PCB concentrations in matreial blood serum (µg/L) for lower (a) and higher (b) chlorinated PCBs.

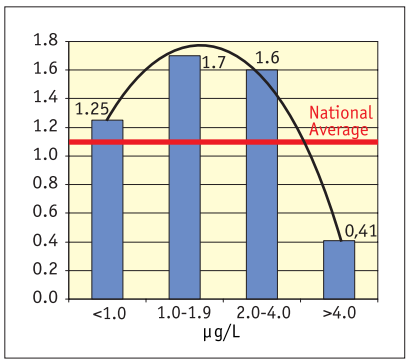


Figure 9.2. Relationship between pregnancy outcome (male/female sex ration of newborns) and total PCB concentrations in maternal serum.

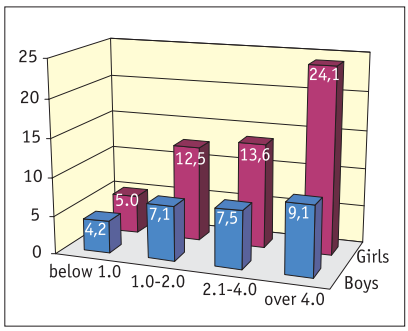


Figure 9.4. Relationship between premature births (earlier than 37 weeks; %) of male and female newborn and total PCB concentrations in maternal serum.

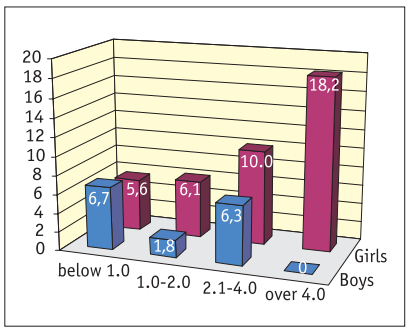
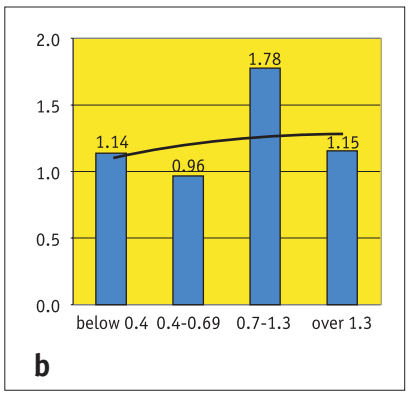


Figure 9.5. Relationship between low birth weight (under 2500g, %) in male and female newborn and total PCB concentrations in maternal serum.



comes for female newborns is closely correlated with total PCB concentrations measured in maternal serum (Figures 9.4 and 9.5).

9.2.3.1.4. Confounding factors

Unlike tobacco smoking, alcohol abuse has been confirmed as a severe reproductive health risk factor, and thus, might act as a confounder to PTS induced reproductive health effects. In order to rule this out, data for women who did not report drinking hard liquor, was analyzed separately by levels of PTS exposure, for selected pregnancy outcomes.

Lead concentrations of over 30.0 µg/L in maternal blood and PCB concentrations in serum of over 2.0 µg/L, may have affected gestational age, as well as the prevalence of stillbirths and spontaneous abortions, and compound with alcohol intake. However, it is important to note that for other contaminants (DDTs, HCHs, toxaphens, chlordanes) at observed exposure levels had no prevalence of reproductive health and developmental effects for non-drinking women and women who reported moderate and hard alcohol intake.

9.2.3.2. Prevalence of chronic diseases

The prevalence of reported health problems related to known chronic diseases among indigenous men over the age of 40, was not found to show a close association with measured current blood concentrations of PTSs (Table 9.30). This was possibly due to poor awareness regarding the manifestations and symptoms of the various health disorders.

Contaminants	Blood concentrations in maternal blood	
	Boys	Girls
Total PCBs (ng/g)	391 ± 61	471 ± 79
Arochlor 1260 (ng/g)	872 ± 142	1089 ± 230
ΣHCHs (ng/g)	279 ± 74	413 ± 66
ΣChlordanes (ng/g)	48 ± 27	78 ± 18
ΣDDTs (ng/g)	618 ± 51	773 ± 92
HCB (ng/g)	160 ± 49	187 ± 41
ΣToxaphene (ng/g)	18 ± 7	22 ± 8
Cd (µg/L)	0.9 ± 0.1	1.0 ± 0.2
Pb (µg/L)	45 ± 7	50 ± 11
Total Hg (µg/L)	1.9 ± 0.4	2.2 ± 0.3

Table 9.29. Concentrations (geometric mean) of PTS in maternal blood and gender of newborns.

In contrast the indigenous women of the same age showed quite a significant association between the prevalence of reported chronic diseases and elevated blood concentrations of some PTS, particularly that of Pb. (Table 9.31).

PTS			Do you have a chronic disease?		Total
			No	Yes	
ΣHCHs	below 1.0 µg/L	n	6	5	11
		%	54.5	45.5	100.0
	1.0 µg/L and over	n	9	13	22
		%	40.9	59.1	100.0
RR				1.30	
ΣClordanes	below 0.1 µg/L	n	8	7	15
		%	53.3	46.7	100.0
	0.1 µg/L and over	n	3	7	10
		%	30.0	70.0	100.0
RR				1.50	
ΣDDTs	below 2 µg/L	n	4	4	8
		%	50.0	50.0	100.0
	2 µg/L and over	n	11	14	21
		%	38.1	61.9	100.0
RR				1.24	
HC B	below 1.0 µg/L	n	7	6	13
		%	53.8	46.2	100.0
	1.0 µg/L and over	n	9	12	21
		%	42.9	57.1	100.0
RR				1.24	

Table 9.30. Reported chronic diseases and concentrations of PTS in blood of indigenous men over 40 years of age.

PTS			Do you have a chronic disease?		Total
			No	Yes	
Pb	**below 30 µg/L**	n	9	2	11
		%	81.8	18.2	100.0
	30 µg/L and over	n	22	26	48
		%	45.8	54.2	100.0
Chi-square test (p-value)				0.03	
RR				3.0	
ΣHCHs	**below 0.1 µg/L**	n	13	7	20
		%	65.0	35.0	100.0
	0.1 µg/L and over	n	23	37	60
		%	38.3	61.7	100.0
Chi-square test (p-value)				0.10	
RR				1.8	

Table 9.31. Reported chronic diseases and concentrations of PTS in blood of indigenous women over 40 years of age.